Knowledge Management System Architecture For Organizational Learning With Collaborative Environment

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Abstract: Knowledge management system (KMS) is one of the most critical weapon to transform knowledge resources in organization into intellectual capital for competitive advantage. However, learning organizations (LO) still have difficulties in identifying an appropriate KMS architecture framework and KMS technologies for their organizations. There is also no clear mechanism on how to motivate and encourage a community of practice (CoP) to share and reuse knowledge, as well as to generate new knowledge in a collaborative environment. Therefore, this research aims to overcome these problems by developing a KMS model and architecture that would ensure the right knowledge could be acquired from and disseminated to the right people at the right time. A survey to a group of CoP was conducted to identify requirements as a basis for setting up a KMS model. The KMS model was used to develop a KMS architecture. The KMS architecture consists of an application layer, a technology layer, an infrastructure layer and a repository layer. This architecture was tested by developing a KMS prototype for a research and development CoP in a Public Higher Learning Institution (PHLI) LO. The system has developed by integrating Lotus Notes Script and JavaScript, which were ran over an Intranet and Internet infrastructure. Agent technology was used in the system for profiling, notification, alert and monitoring. Another questionnaire survey was conducted after the KMS prototype implementation to verify the functionality of the system in facilitating knowledge sharing in a collaborative environment. The findings from both questionnaire surveys were compared to identify the effectiveness of KMS implementation in creating a collaborative environment for knowledge sharing, re-use and creation in a CoP. The study found that the use of agent technology in a KMS supports the creation of a collaborative environment in a CoP.

Keywords: Knowledge, Knowledge Management, Knowledge Management System (KMS), Collaborative technology, Agent Technology and Learning Organization.

1.0 Introduction

Knowledge comes from information processed by using data. It includes individuals' experiences, values, insights, and contextual information and helps to evaluate and incorporate new experiences and information. Knowledge originates from and is applied by knowledge workers. People use knowledge in making decisions. During the last several years, organizations realize they own a vast amount of knowledge and that this knowledge needs to be managed (Satyadas *et al.*, 2001). Davenport and Prusak (1998) define knowledge as a fluid mixture of experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information.

In organizations, it becomes embedded in documents and repositories, in organizational routines, in processes, practices, and norms. There is a slight difference in the definition given by Alavi and Leidner (1999). The speed, flexibility and efficiency are important within the application and the development of knowledge. It is also important to have the best of knowledge at the right place and at the right time and at a minimal cost as well. By looking at the power and importance of knowledge to work collaboratively, there is a need for a system known as knowledge management system (KMS) in order to allow people to work together at any given time, place and also regardless of any platform that they have. Furthermore,

Tiwana (2002) has classified or categorized a KMS architecture model that consists of seven layers. The layers are interface, access, collaborative, application, transport, integration, and repositories. These layers should be revised for a collaborative environment to encourage a LO CoP to work more easily, efficiently and effectively to be more productive to the organization.

2.0 Literature Review

Knowledge exists when data and information are applied (Beckett *et al.*, 2000). According to Nonaka and Takeuichi (1995) knowledge could also be categorized into two types, explicit and tacit knowledge. Tacit knowledge is obtained by internal individual process and stored in human being like experience, reflection, internalization or individual talent. Explicit knowledge is possible to be stored in a mechanical or technological way, like in handbooks or information systems, or database, manual, internal newsletter, documentation. Knowledge management (KM) is very important in the 1990's because it will help organization to have competitive advantage and effective work through sharing and re-use of knowledge in an organization. In the market place of e-business, KM initiatives are used to systematically leverage information and expertise to improve organizational responsiveness, innovation, competency and efficiency. There are many reasons why knowledge should be managed properly in an organization. Among the reasons are as follows: information overloads, technology advancement, increased professional specialization, competition, workforce mobility and turnover, and capitalizes on organizational knowledge.

The KMS architecture is a fundamental issue in the area of KM that must be well resolved in order to deliver competitive services to the users as well as the organization. Meso and Smith (2000) proposed a KMS architecture that processes a combination of all the aspects stated below as well as other components which able to perform according to the requirement of the organization. These components consist of technology, function and the knowledge by itself. In terms of technology, KM should have the following features such as computer–mediated collaboration (CMC), e-mail, video conferencing, web browsing (portal), search engine, intelligent agent, and document management. Furthermore, in terms of its functionality, KM involved the processes for acquiring or collecting, organizing, disseminating or sharing knowledge and using knowledge among the stakeholder.

And lastly, KMS implementation should be looked on its content of knowledge in terms of how to answer certain questions such as know-how, know-what, know-why, know-who and so on. Collaboration environment provides a framework for bringing heads together, organizing their efforts, managing the process and producing outstanding results. When each member of a team collaborates on a mission or project, each would be able to contribute his or her own strength, skills and knowledge, to ensure the best results for the project (Attaran and Attaran, 2002). Cooperation, collaboration and teamwork are essential to the survival of any organization. Many realize that the importance of teamwork and collaboration may lead to the successful conduct of business. Collaboration also could be done using agent technology as support tools for team members who will to work at any given time and place. A collaboration model that was proposed by Khoshafian and Buckiewicz (1995) is shown in Figure 1 below.

	Same Time	Different Time
Same Place	Face-to-face collaboration (Synchronous)	Asynchronous Collaboration
Different Place	Distributed Synchronous Collaboration	Distributed Asynchronous Collaboration

Figure 1: Collaboration Model

3.0 Methodology

This research is organized into several phases starting from Phase One that describes the performance of fieldwork such as literature study and pre- KMS implementation, which is develop and distribute the questionnaire as well as to produce the model and architecture for KMS related with collaborative environment. The questionnaire was developed based on the area interest in KMS from the literature study, namely: General Information of Organization Tenure, KM Concept and Capabilities, KM Infrastructure and Technologies, and KM Cultures. The survey has been conducted by disseminated the questionnaires to the particular participants that involved in the KMS development and intend to use KM system for their purposes in a community of practice. The profile of the participants is shown in Table 1 below.

Table 1: The profile of the participants

Type of Community	Position	No. of Respondents
KM Dev. Team	- CKO, SA and PR	5
IRPA Group1	- Manager and RA	3
IRPA Group2	- Manager and RA	3
IRPA Group3	- Manager and RA	3

And then, followed by the Phase Two that implements the KMS Prototype using collaborative technology and Lotus Notes groupware and scripting language such JavaScript. After that, in Phase Three, another round of questionnaire was distributed to the respondents (Post-KMS implementation). A comparison is made between the Pre and Post KMS implementation. In Phase Four, the KMS model and architecture was revised. Lastly, followed by Phase Five for concludes of the study.

4.0 A Case Study

Based on the KMS survey results and the literature review that has been done, its show the architecture of pre-KMS implementation should be considered in terms of protocol interface application, technology, infrastructure, and repository in order to support knowledge sharing in the organization. Then, KMS is capable to perform as a knowledge portal using the collaborative technologies by supporting the networking infrastructure in order to process knowledge in the CoP. Besides that, psychological and cultural issues, as well as a knowledge audit should be considered in the process of pre-KMS implementation to ensure KMS is working successfully.

In this case study, the development of KMS prototype as a knowledge portal for LO so called Collaborative Research Management Portal Environment for Learning Organization or CoRMPeLO has been developed and implemented by supported with agent-based system in term of agent services such as profiling, notification, alert and scheduler system. This system is developed based on the research management unit in a public higher learning institution (PHLI) as a case study because this research unit involves a CoP that includes administrators, researchers, RAs and others. The system configuration and workflow operation of the KMS prototype with agent technology is shown in the Figure 2 and Figure 3 below.

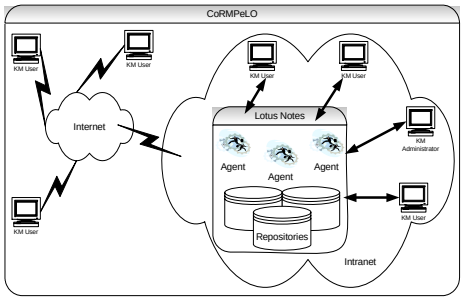

Figure 2: KMS Configuration System

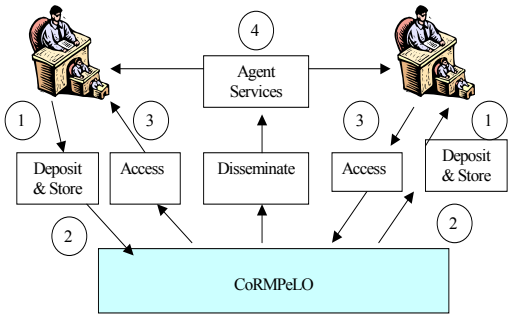

Figure 3: The Workflow of KMS Operation

5.0 Results and Discussions

The critical factors consideration could be viewed in terms of the following aspects in order to ensure KMS implementation is successful in the organization. This includes pull and push technology, notification technology, knowledge discovery technology, knowledge documentation, knowledge quality and productivity, and human computer interface technology. Beside that, several improvement factors have been considered for KMS measurement. These include time and cost, security elements, easy access, knowledge resources, documentation, quality and productivity of services.

- Pull technology

In the context of pull technology that is involved in the KMS implementation between before and after, we found that portal has given impact with more than half of the respondents, while the spider and forum has given impact for more than three quarter of the respondents. This impact shows that these technologies have played important role to disseminate knowledge in a community. This include the use of e-mail and other technology like search engine, which is well known in term of their capabilities to support the community to perform the works or tasks. The detail of the result is shown in Figure 4 for asynchronous technique in dissemination of knowledge. But for the synchronous technique of acquisition of knowledge, we found that the use of teleconferencing and video conferencing is much better for knowledge sharing in community as shown in Figure 5.

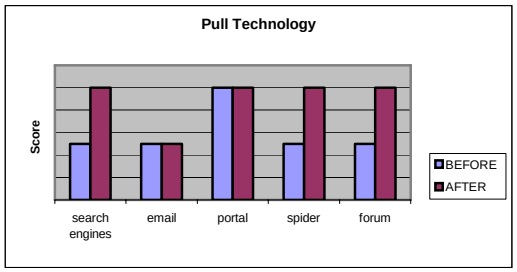

Figure 4: Bar Chart of Pull Tech. in Asynchronous of KD

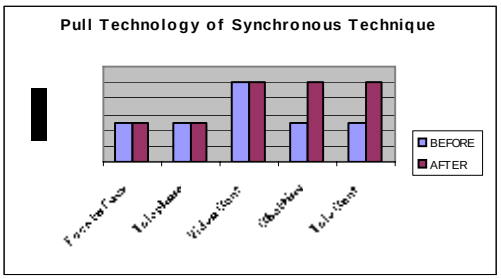

Figure 5: Bar Chart of Pull Techn. in Synchronous of KA

- Push Technology

This technology has given more significance in term of the use of forum and spider or agent technologies are much better for sharing of knowledge in the organization as shown in Figure 6. This technique is very useful especially in asynchronous mode of knowledge dissemination rather than the synchronous mode of technique.

- Notification Technology

This technology has also given more significance in the use of intelligent agent for the organization. This is because as shown in Figure 7 where it was indicated that almost all of the respondents agreed this technique is very useful in order to notify the community about the existing knowledge in an asynchronous mode of KD. The agent will work on behalf of the community at a particular time without human intervention.

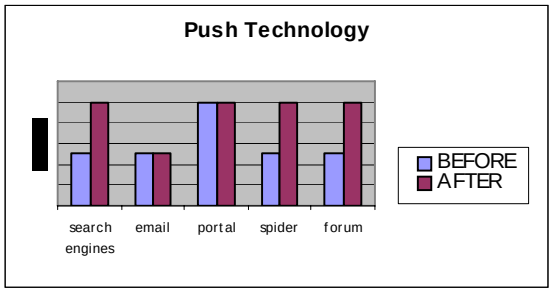

Figure 6: Bar Chart of Push Tech. in Asynchronous

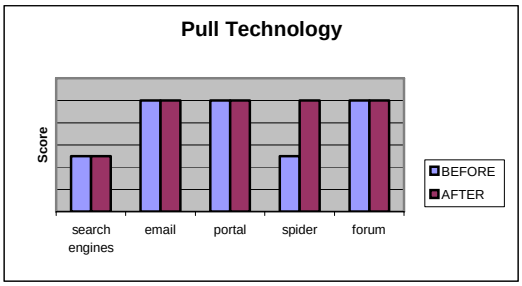

Figure 7: Bar Chart of Notify Tech. in Asynchronous

- Discovery and Capturing Technology

In the context of knowledge discovery technology, the research has shown that the use of search engine is more helpful to the community, where 12 of 14 respondents agreed about its helpfulness as indicated in figure 8. Besides that, there is 11 of 14 respondents also agreed that the usefulness of the support of agent based system such as spider to work in KMS implementation as indicated in Figure 9.

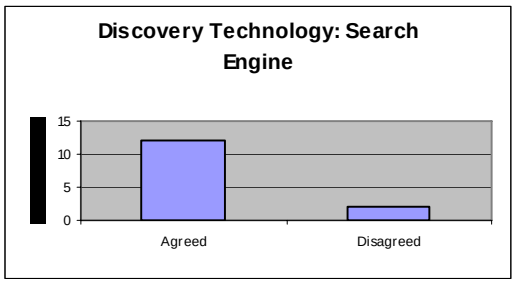

Figure 8: Discovery of Technology of Search Engine

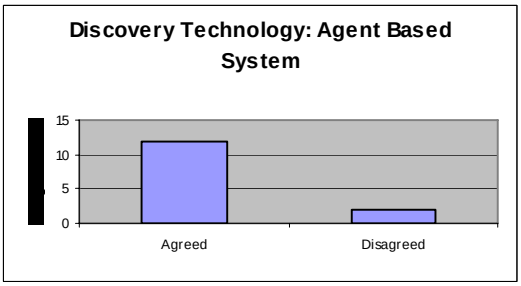

Figure 9: Discovery of Technology of Agent-Based System

- Publish (Documentation)

In the context of knowledge documentation technology, the research has shown that the knowledge used of is more organized, where 12 of 14 respondents agreed about its well organization as indicated in Figure 10. Besides that, there is 12 of 14 of respondents also agreed that the usefulness of the supported of digital format that to ensure KMS implementation performed well and according to the specification. Please refer to Figure 11 as shown below.

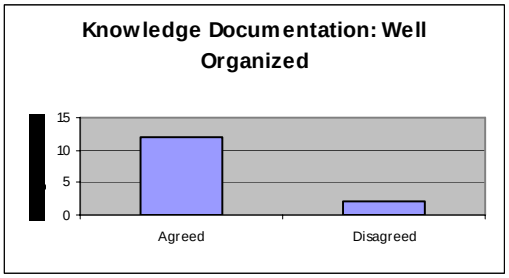

Figure 10: Agreement on Well Organized

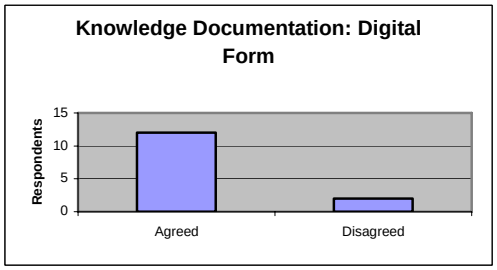

Figure 11: Agreement on Digital Based Format

- Quality and productivity

In the context of the increment of quality and productivity of working, the research has shown that the working environment has been increased, where 10 of 14 respondents agreed about the matter. Beside that, 10 of 14 respondents also agreed the productivity is increased by implementing the KMS in the organization. Please refer to Figure 12 and Figure 13 as shown below.

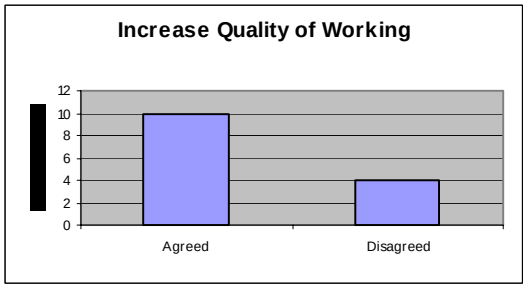

Figure 12: The Increment of Quality of Work

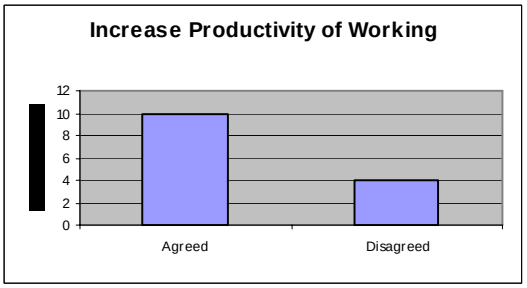

Figure 13: The Increment of Productivity of Work

- Human Computer Interface (HCI)

In the context of human computer interface aspect, the research has shown that the used of GUI based environment has been helpful, where 10 of 14 respondents agreed about the matter. Beside that, there is 10 of 14 respondents also agreed that the used of icon based in the KMS implementation in the organization. Please refer to Figure 14 and Figure 15 as shown below.

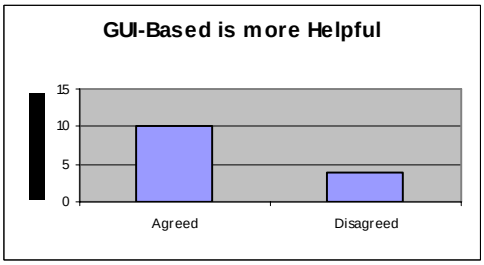

Figure 14: GUI-based of HCI Aspect

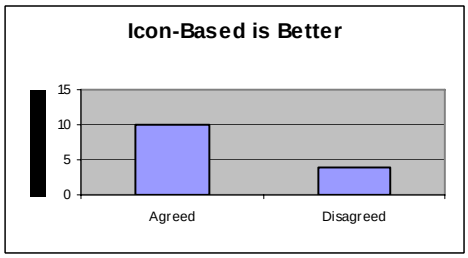

Figure 15: Icon-based of HCI Aspect

As an overall conclusion of the research, we found that, there are some improvements of the measurement of factors indicator that could be viewed of KMS implementation by using the collaborative technique and technology in the organization. These improvements should be looking in terms of the following aspects:

- Time: This is about the performances of the system in term of speed up the process of doing some things that regard with the user requirement. Figure 16 shows 10 of 14 respondents agreed about this matter.

- Cost: The reduction cost factor in term of searching of knowledge as well as to avoid error of doing tasks or assignment for the specific jobs of the future is of significant impact. This is because almost all of respondents agreed about it as stated in Figure 17.

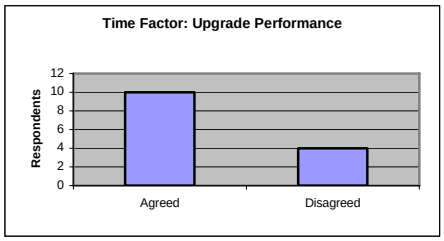

Figure 16: Upgrading Performance On The Time

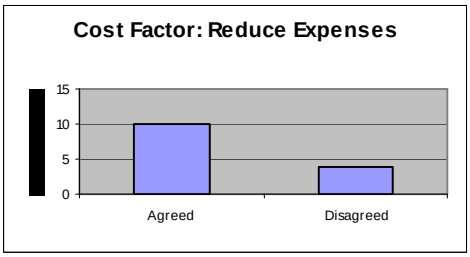

Figure 17: The Reduction of Expenses for Cost

- Security: Those who are have privilege that could be used and right to get access into the system. About 10 of 14 respondents agreed about the importance of security in KMS, which increase their confidence as shown in Figure 18.

- Easy Access: This is about the easiest way to access the knowledge in order to ensure the KM technology such as Internet, Intranet and Extranet facility is fully working according to the requirement as shown in Figure 19.

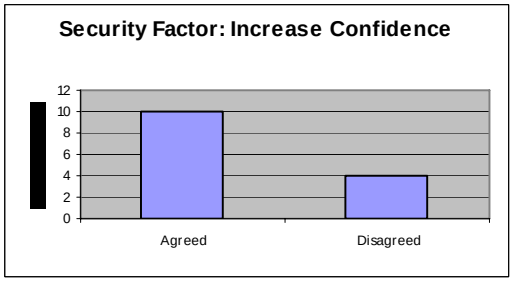

Figure 18: Increasing Confidents of Security

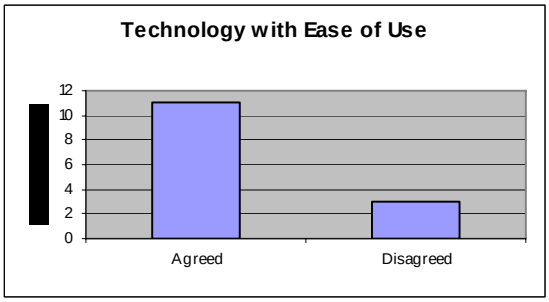

Figure 19: The ease of use of KMS

- Resources: This is about the resources (also called asset) available in the organization, which is more utilized and organized. This result has shown that about 11 of 14 respondents agreed of this matter as shown in Figure 20.

- Documentation: In the context of knowledge documentation, the more knowledge it is converted into the documents that are in the digital of form the better. This phenomenon could be viewed in the diagram Figure 21 where 11 of 14 respondents agreed on the matter.

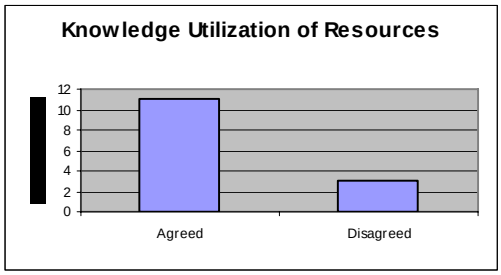

Figure 20: The Utilization of resources

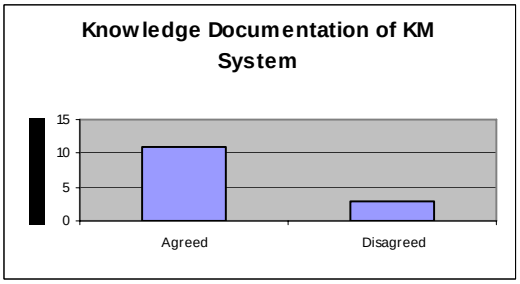

Figure 21: Technology of Knowledge Documentation

- Quality and productivity: In the context of quality and productivity, there are about 11 of 14 respondents agreed in terms of the increment of the quality and productivity where more document could be used and accessed by using the system.

- Human Computer Interface (HCI): The system that has been developed should be provided with interesting interface and user-friendly. Eleven of fourteen respondents agreed about the characteristics.

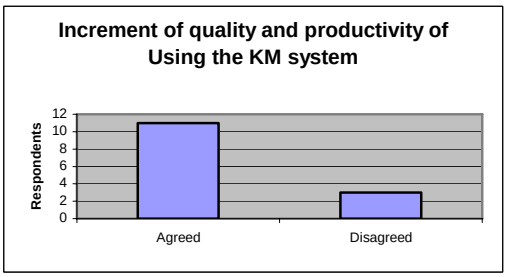

Figure 22: Quality and productivity Increment

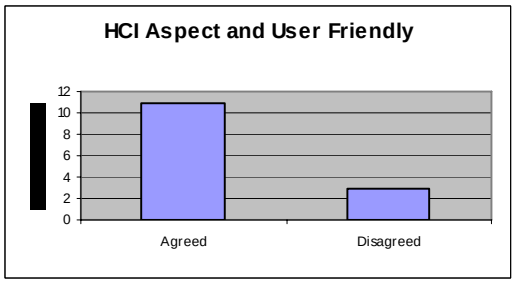

Figure 23: HCI aspect and User Friendly System

And as a last conclusion, in term of the percentage of system improvement, there are four of twelve factor indicators of post KMS. These include pull technology that is used in knowledge acquisition in term of asynchronous and synchronous as well as push technology for notify and alert that is used as intelligent agent in acquisition and dissemination of knowledge. In this context, it shows improvement of post KMS compared with the pre KMS implementation. Therefore, it indicates that the outcome of this research is significant and delivered a good impact to the organization. A revised KMS model and its architecture has been made because there are other components that should also be considered such as the taxonomy component with related to the knowledge repository, the detailed specification on technique, and technology involvement in a collaborative environment.

So, we have proposed the new KMS model and architecture for LO that consists of six main components in order to serve community of KMS with collaborative environment to work together for a certain mission in the organization. These components include: Architecture, Functionality and Application, Taxonomy and Process, Culture, Psychological and Audit, so called AFTPCAS Model are identified as a KMS architectural framework for a collaborative environment in the LO. The connectivity of the multiple issues and aspects plays a major role in KMS model and architecture after modification as the outcome of research is shown in Figure 24.

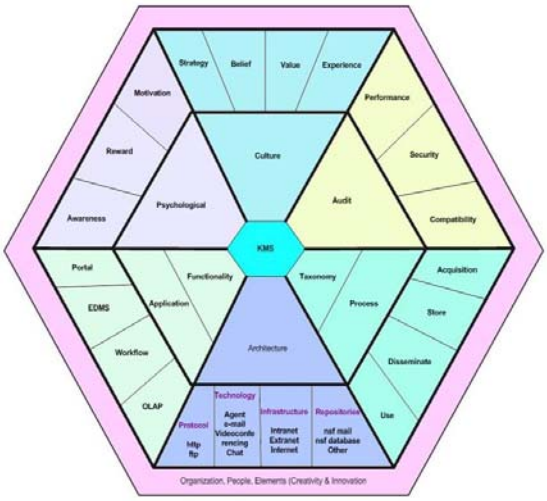

Figure 24: The Modification of KMS Model and Architecture

6.0 Conclusion

As the findings of this research, we found that KMS architecture could be developed by using four layers, which includes protocol layer as a top level one in order to allow to become as a user interface application with the community, and followed by technology layer that facilitate the community to work together to share, re-use and generate knowledge among them. We also found that the KMS model could be shown in seven components in the AFTPCAS KMS model that includes the functionality and system architecture as the backbone to support the KMS process, taxonomy deployment, and cultural aspects as well as the knowledge strategies and measurement or system auditing. The functionality of system may consist of a Portal, EDMS, Workflow management, Data Warehouse and Artificial Intelligence such agent technology. In a complex KMS, which covers the whole knowledge cycle, the minimum technologies requirement would be:

- Intranets, Electronic Document Management System (EDMS),
- Information Retrieval (IR) technique, Relational and Object Database system,
- Electronic Publishing System,
- Groupware and Workflow System,
- Agent Technology and, Data Mining Tools.

The KMS is good work area where people can share their knowledge between the CoP from the KMS model and architectural framework as proposed to be used in the organization. In this case, agent technology is also identified as an effectiveness tool and applied in order to act on behalf of the people in the community in order to perform something repetitively and time based system.

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